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ABSTRACT

The effects of specific testing procedures on learning were studied, using the chunking method of teaching and studying, which involves the learning of small units of information. The size of the unit is related to the student's cognitive processing capacity (CPC)--the amount of material recalled after a brief exposure. Subjects were undergraduate students categorized as high, medium, or low in CPC. The students were taught the chunking method and then used it to study a textbook chapter. Subjects were offered an end-of-chapter mastery test which might help to improve their final grades; they also had the option of repeating this test if their initial scores were unsatisfactory. Three months later, a test was adminsitered which contained items taken from the end-of-unit test, items from the retest, and new items. Mastery tests and unit retests led to improved scores by 32% and 67%, respectively. Most who retook the tests were low CPC students, and 73% of them improved their letter grades. Long-term beneficial effects were evident; the initial difference between those who repeated the test and those who did not was eliminated on a three-month delayed test. (Author/GDC)

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Chunking Method of Teaching and Studying (III): Test Effects

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Abstract

The individual contributions made to the cognitive processing capacity (CPC) method of teaching and studying by criterion tests and unit retests were investigated. The results showed that criterion tests and unit retests could lead to improved student performances by 32% and 67%, respectively. The majority of those who retook the tests were low CPC students, and 73% of them improved their letter grades. Long-term beneficial effects were evident in that the initially significant difference between those who did retake the test and those who did not was eliminated on a 3-month delayed test.

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Statement of the problem

The chunking method of teaching and studying requires students to learn information in quantities that do not exceed their cognitive processing capacities (CPC) (Furukawa, Cohen, Sumpter, & Hirsh, Note 1; Furukawa, Cohen, & Sumpter, Note 2). As measured by Furukawa's (1977) test, CPC refers to one's capacity to recall information after a single, brief exposure to the materials. The student is also required to chunk the information under a nexus (concept or principle) located at the next higher level on the hierarchical structure of knowledge.

Two earlier experiments supported the use of the chunking method of teaching and studying. The first experiment involved conditionally-accepted students, with Scholastic Aptitude Test, Verbal, scores of 350 or less and low CPC. The students were taught to use the method through a chunking programmed instruction booklet (Furukawa, 1978). The principles were then incorporated into the structure of an undergraduate general psychology course. The students studied individual chapters of an introductory psychology text by using a chunking study outline (CSO) provided by the instructor and then took a criterion test. An end-of-unit test was administered after every third chapter. Students had the option of retaking the test once, with the provision that the grade of the second test was to be their grade for that unit. The application of the chunking method by both instructors and conditionally-accepted students resulted in an

increase in their success rates (a grade of C or higher) from 38% to 90% across two separate classes.

A second experiment demonstrated that the use of the short CSO was more conducive to effective learning than the long version (Furukawa et al. Note 2). The rationale advanced were as follows: (a) The longer outlines may have provided too much information, causing an overload of the student's CPC; (b) the quantity of information also may have impeded chunking, as the relationships among the various concepts and principles were obscured; (c) the availability of the information may have led to its reading or recognition instead of rehearsal through recall of the concepts and their definitions. This same experiment yielded data showing that the chunking method led to an overall recall percentage of 85% of original learning after three months. With the elimination of questions on problem solving, a skill not normally taught in an introductory course, the retention rate of discriminations, concepts, and principles (Gagné, 1965) was 95%. Nevertheless there was some indication that the low CPC students may be handicapped in contrast to the high CPC students on the delayed posttest.

To summarize, the previous investigations began with a broad question as to whether the chunking method of teaching and studying is effective and followed that question with more specific ones on outlines and retention rates.

The present study is an attempt to investigate the contributions made by specific testing procedures to the chunking method of teaching and studying. Specifically, the questions asked in the present study were as follows:

1. Do the chapter criterion tests lead to measurable differences in performances on the end-of-unit tests given after every three chapters?

2. Do retests lead to higher test grades and to increased long-term retention?

3. Do the high CPC students surpass the test performances of the low CPC students?

Subjects

One hundred and eighty-one students in a class of introductory psychology participated in the study. Due to withdrawals from class, absences, and other specific reasons to be considered later, not all of the students are included in all of the data discussed. The mean CPC score of the class was 5.79, with a standard deviation of 2.07. Based on these statistics, the high CPC designation was given to students with a CPC of $\geq$8.00 and low to those with a score of $\leq$4.00. The medium CPC scores were 5, 6, and 7. These divisions resulted in 29 students being categorized as high, 50 as low and 102 as medium CPC students.

Procedure

At the beginning of the course, the students took a CPC test and then mastered the principles of the method through use of a programmed instructional booklet, The Successful Student: Study Skills (Furukawa, 1978). Next, they learned a chapter of the introductory psychology text (Morris, 1977) by applying the chunking method. To facilitate application, a CSO was provided for each chapter. Also a student assistant instructor (a senior or graduate student) was available to each group of 15-20 students. Third, the students were given the option of taking a criterion

test consisting of 20 multiple-choice questions after studying the contents of a chapter. As an inducement to take the criterion test, the students were told that a grade of A or B (85% or 75%, respectively, of the test items answered correctly) would lead to the award of one-third of a point. If at least two-thirds of a point was obtained over the three criterion tests, then an extra point would be added on to the test score obtained on the end-of-unit test covering these same three chapters. The students were also told that the extra point would probably mean a higher letter grade for 20 to 30% of the class and was, therefore, a worthwhile effort. The criterion test would also give the students an indication of their end-of-unit test scores; that is, an A or B on the criterion test would probably mean that they would get an A or B on the end-of-unit test. An unmeasured aspect, of course, was the higher grades achieved on the end-of-unit test as a result of the effort expended in passing the criterion test. If the students failed to get an A or B on the criterion test, an analysis of errors was made and further study of weak areas encouraged.

For all of the end-of-unit tests (40 multiple-choice questions) except the last one, the students were given the option of retaking the test if they did not obtain a grade of A. If this option was exercised, the grade for the unit was based on the second test, be it higher or lower than the original test score. The students were always given a minimum of two days to prepare for the retests. For the purpose of allowing retests, several alternate forms of the tests were prepared.

A 12-item multiple-choice test covering the materials on the first unit was administered after approximately three months

had elapsed since the end-of-unit test. The test items were evenly divided into questions which were on the initial test, questions which were only on the retest, and questions which were on neither of the previous two tests.

Results

The data are presented in the same order in which the questions were asked earlier; namely, questions on criterion tests, retests, and CPC. The analyses of criterion tests and retests were limited to the first of the introductory psychology tests because the immediate posttest (IPT) versus delayed posttest (DPT) comparison was based on the first test.

Criterion tests appeared to be beneficial in raising test grades. That is, the addition of the single point to the first end-of-unit test score increased the letter grades of 13% of the students. Furthermore, 19% of those students who did not complete the required number of criterion tests could have raised their letter grades by taking the tests.

The retest for the first end-of-unit test was taken by 46 students. A significant number (31 or 67%) of them attained a higher letter grade while no one experienced a drop in letter grade, X^2 (1) = 4.88, $p \leq .05$. The means and standard deviations for the original and retest scores were 24.15, 5.51 and 28.22, 5.44, respectively.

The retention rate over a period of approximately three months was evaluated by a 2 X 2 factorial design. The original plan was to determine whether there would be any differences among the three types of test questions; namely, the questions which were on the original test, the questions which were on the retest but not on the original, and new questions which

appeared on neither of the two earlier tests. However, no significant differences were found between the test and retest groups on these questions. Therefore, the analysis of variance was conducted on the posttests (IPT and DPT) collapsed across all types of test questions for the no-retest and retest groups (see Table 1).

Insert Table 1 about here

The analysis showed no significa t difference between no-retest and retest groups, but there was a significant difference between IPT and DPT, in favor of the former, F (1, 32) = 32.45, $p < .001$. There was a significant interaction, F (1, 32) = 6.92, $p < .025$. The source of the interaction was a significant difference, F (1, 32) = 8.45, $p < .01$, on the IPT between the no-retest and retest groups favoring the former but no significant difference on the DPT. A separate analysis showed a pretest to DPT gain of 88%.

As for the third question on differences in performances between high and low CPC students, a significantly larger percentage (90%) of high CPC students as compared to 71% of the low CPC students completed two or three criterion tests, X^2 (1) = 7.42, $p < .01$. Furthermore, more than twice as many A's and B's were obtained by the high CPC students with about a fourth less D's and F's on the first test. Consequently, a significantly larger proportion of the low instead of the high CPC students retook the test (31% of 49 vs. 17% of 29), X^2 (1) = 4.08, $p < .05$. Of the 5 high CPC students who retook the test, 60% increased their letter grades and of the 15 low CPC students

who retook the test, 73% increased their letter grades. Because of the small number of high CPC students retaking the test, no statistical comparisons were made. Nevertheless, the difference between the means of the two groups decreased somewhat from 7 to 5.53 from test to retest. The correlations between CPC scores and test scores were .37 and .40 on the test and retest, respectively, both coefficients being significant at the .001 level, with a df of 76.

The foregoing findings led to a post hoc analysis of final grades received by the class. The final grade, assigned by averaging letter grades across five tests, showed the percentage distribution given in Table 2. Note that 93% of the high

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Insert Table 2 about here

CPC students and 86% of the low CPC students successfully passed the course, with grades of C or higher. This difference in success rates was not significant.

Conclusions

Chapter criterion tests appear to have a direct effect on letter grades under the conditions specified here, where one point can be added to end-of-unit test scores. That is, 13% of the students increased their letter grades by achieving the additional point. What is not apparent from these percentages, of course, is the degree of achievement attained because of the effort made in reviewing for and after the criterion tests. By analogy, if we consider the evidence of the value of the retests found on the IPT, DPT, and no retest, retest analysis, studying for the criterion tests seems to be recommended. As shown, on

the original test there is a significant difference between the two groups (those who took only the original test and those who retook the first test), favoring the group that did not retake the test. However, there is no significant difference between the two groups on the DPT after the intervention of the study for the retest.

The retests also appear to be a beneficial part of the chunking method of teaching and studying. Of the 46 students who retook the test, 31 or 67% improved their letter grades. Since a larger proportion of low instead of high CPC students retook the test, the option of retaking tests is certainly to the advantage of the former. This advantage becomes doubly important when the retention rates are examined. The results indicate that retaking the tests increases long-term retention of the information so that the significant difference that existed on the original test is eliminated. In fact, the mean of the students who retook the test is slightly higher on the DPT. And a pretest-posttest comparison shows an 88% increase in knowledge across all students.

Clearly the high CPC students appear to have an advantage over the low CPC students. More than twice as many A's and B's were obtained by the high CPC students with about a fourth less D's and F's on the first test. Stated in terms of mean grades, the high CPC students scored about 5½ points better on the 40-item test. Table 2 shows, however, that it is possible for an equal number of high and low CPC students to pass the course. We should note, nevertheless, that the chances of failing are proportionately greater for the low CPC students,

that is, students with CPC scores of $\leq$ 4.00. As for the criterion tests, they appear to benefit the low CPC students more than the high CPC students when an additional point can be earned through achieving a grade of A or B. Despite this finding, the criterion tests are probably equally as helpful to both groups of students by encouraging them to study and providing them feedback. The retests are also especially beneficial to the low CPC students, as indicated by the data. Overall, low CPC appears to place a limitation on the quantity of information which can be processed at one time, and it may affect the final achievement of these students. More than likely, the students need more rehearsal time and greater reliance on study strategies. With the successful application of the chunking method of teaching and studying, however, the low CPC students appear to be able to equal the passing rates of the high CPC students.

To summarize, the criterion tests and unit retests do make positive contributions to the chunking method of teaching and studying, and consequently, they do add to the overall success rates of the students.

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Table 1. Means and Standard Deviations on Immediate and Delayed Posttests for Retest and No-Retest Groups.

Groups	Immediate Posttest	Delayed Posttest
Retest	Mean: 4.87 SD: 1.16	Mean: 4.23 SD: 1.18
No-Retest	Mean: 5.88 SD: .84	Mean: 4.16 SD: 1.12

Table 2. Final Grade Distributions

Cognitive Processing Capacity	A & B Grades	C Grade	D & F Grades
High	83%	10%	7%
Medium	59%	26%	15%
Low	44%	42%	14%